USE OF SCRAP TIRE RUBBER IN ASPHALT PAVEMENTS

A Report to the Governor and Legislature
in Compliance with Chapter 599
of the Laws of 1987

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
State Office Building Campus
Albany, N.Y. 12232

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
ALBANY, N.Y. 12232

FRANKLIN E. WHITE
COMMISSIONER

September 28, 1990

The Honorable Mario M. Cuomo
Governor of the State of New York
State Capitol
Albany, New York 12224

Dear Governor Cuomo:

Pursuant to the requirements of Chapter 599 of the Laws of 1987, I am pleased to submit our engineer's report on the Use of Scrap Tire Rubber in Asphalt Pavements.

Two pilot projects were undertaken in 1989 using the material in comparison tests with conventional asphalt mixes. The report describes the experience with the pilot projects, but notes that several more years of observation will be required before it will be possible to draw any conclusions as to service lives and life cycle costs for rubber-modified asphalt compared to conventional asphalt mixes. We will continue to evaluate these projects during the next several years and will include a summary of our evaluation in the Department's Annual Reports.

While the cost of the rubber mixes has been significantly higher than conventional asphalt, the cost could be expected to be reduced were it to be used more widely. This engineering report responds to specific questions from the legislature, is limited in its scope and therefore considers only the increased costs to the State highway system. Were the avoided cost of conventional disposal methods taken into consideration, it may well make asphalt rubber a more attractive option. (It should be noted, however, that the rubber-modified asphalt process utilizes only about one-third of the tire carcass.) I am providing a copy of this report to Commissioners Jorling and Tese for their comments and suggestions on that aspect of the scrap tire issue.

The report also reviews the general experience of other states that have had test installations of the rubber asphalt materials and covers a number of other matters relating to the use of tire rubber for highway pavements as required by the legislation.

We trust the information in this report will be helpful in the development of alternative strategies for the disposal of scrap tires. However, it should not be considered as a definitive report on this issue. It is merely another chapter in our Department's continuing effort to use recycled waste products in its highway program.

A copy of this report and a similar letter have been sent to the Senate President Pro Tem and Majority Leader, Ralph J. Marino, and to the Assembly Speaker, Melvin H. Miller.

Sincerely,

FRANKLIN E. WHITE
Commissioner

Table of Contents

USE OF SCRAP TIRE RUBBER IN ASPHALT PAVEMENT

A REPORT TO THE GOVERNOR AND LEGISLATURE IN COMPLIANCE WITH CHAPTER 599 OF THE NEW YORK STATE LAWS OF 1987.

Chapter 599 of the Laws of 1987 required the New York State Department of Transportation (NYSDOT) to undertake a pilot project for the use of rubber-modified asphalt in the construction or improvement of State highways. (See Appendix for a copy of the legislation.) The rubber was to be derived from tires discarded in the State. In addition, NYSDOT was required to investigate and report on the economic, environmental, technical and other implications of the use of scrap motor vehicle tires in asphalt pavements. In a separate legislative action, an appropriation of $300,000 was included to fund the above efforts and an additional similarly required evaluation of use of coal combustion by-products in highway projects. (See Appendix for copies of these actions.)

BACKGROUND

This 1987 legislative requirement followed an earlier effort which Governor Mario M. Cuomo directed the Department of Transportation to survey the research carried out on the use of scrap rubber tires for highway construction, to recommend additional research or other actions appropriate for New York to carry out and to estimate the economic impact of using scrap rubber tires in highway paving materials.[1] The Department produced a report in May 1986 in response to the Governor's directive.[2] The report noted that waste rubber is already included in the Department's specifications for liquid joint and crack-sealing materials for pavement, but that experimental data on the performance and durability of rubber-modified asphalt for highway pavement was inconclusive. Rubber-modified asphalt was estimated to cost 60 percent more than conventional asphalt mixes, although it was acknowledged that costs for the product could be expected to be reduced were it to be widely used and in high volume production levels. The 60 percent higher cost for the rubber-modified asphalt compared to conventional asphalt pavement materials equated to $11 for each tire thus being disposed of.

The 1986 report recommended that test installations of a rubber-modified asphalt product be considered, but until the cost effectiveness of using the product could be shown, widespread use of the product was discouraged. It was also recommended that the environmental and health effects resulting from the use of the scrap rubber with its content of known carcinogens in the high temperature asphalt mix should also be evaluated before widespread use of the product.

PILOT PROJECTS

In compliance with the 1987 legislative provisions, NYSDOT has two pilot resurfacing projects designed and constructed with recycled New York State waste tire rubber incorporated in hot-mix asphalt concrete. The two contracts were competitively bid. Contracts were

awarded to the two successful bidders and construction completed in the summer of 1989. One of the projects is in the Town of Bethlehem, Albany County, on Route 144 and the other is in the Town of Deposit, Delaware County, on Route 17. At both sites, each of five different mixes were applied in separate adjoining 2,000 foot sections of highway as follows: 1, 2 and 3 percent crumb rubber, respectively, a proprietary product called Plus-Ride containing 3 percent rubber, and a conventional asphalt concrete mix, which was used as the experimental control.

RESPONSES TO ISSUES

Since the placement of the resurfacing materials occurred only a year ago, there is insufficient experience to judge the longer term service life of the various test sections. However, this report will provide responses to the issues enumerated in the legislation on the basis of the test installations through the construction phase, together with information gathered from laboratory evaluations and test installations made elsewhere. The following is in response to the matters enumerated in the legislation, taken up in the sequence listed in the legislation.

A comparison of costs of conventional asphalt mixes to the costs of the use of rubber-modified asphalt:

As noted, the Department's earlier report[2] estimated that the use of rubber-modified asphalt would increase costs by 60 percent over conventional asphalt. The low bids for the two pilot projects showed the following increases over the conventional asphalt mix bid price for each of the rubber-modified asphalt mixes:

Bid Price Relationships for
Rubber-Modified Asphalt Mixes
Compared to
Conventional Asphalt Mix

Mix	Albany County Project	Delaware County Project
1% Rubber	+ 50%	+ 114%
2% Rubber	+ 50%	+ 114%
3% Rubber	+ 50%	+ 114%
Plus-Ride, a proprietary rubber product	+ 50%	+ 114%

These competitive bid prices from the respective lowest price bidders reflect the individual contractor's perception of the relative costs (including the element of contingencies and risk) associated with using each of the previously untried rubber-modified asphalt mixes compared to the tried and true conventional asphalt mix. It should be recognized that the bid prices showing costs of from 50 percent more than the usual asphalt mix to more than double the cost should not be taken as indicative of what costs might be were the rubber-modified asphalt mixes to be in widespread use.

Current projections by the Federal Highway Administration (FHWA)[3] are that the cost for rubber-modified asphalt when in full production can be expected to be 20 to 30 percent higher than conventional asphalt mixes. Our current estimate, based on costs experienced in the pilot projects and costs reported by others, is that the future costs can be expected to be closer to 50 percent higher for rubber-modified asphalt. The actual cost difference will be dependent on the percent of rubber added to the mix, whether or not a proprietary product is used, the experience of the industry with the product and market forces that will affect the price of scrap rubber tires. If the asphalt concrete used for the surface and binder courses of highway paving in New York State annually were to contain 2 percent rubber, the total annual cost of the highway program would be increased by as much as $100 million over what would be incurred using conventional asphalt mixes, or, within existing funding, it would require reducing annual highway surfacing programs by one-third.[2]

The factors which cause rubber-modified asphalt to be more costly than conventional asphalt mixes are not only the cost of the granulated rubber, but also the need for an increase in the volume of asphalt cement binder when using rubber, the need for a more costly aggregate (stone) and filler gradation, increased energy to heat the asphalt mix to the higher temperature required for a rubber-modified mix and to extend the mixing time to assure proper mixing, increased plant labor to handle the rubber additive (this might largely be replaceable with investment in additional automated equipment) and increased labor and equipment costs at the highway work site.[4] Another factor affecting cost is that the rubber-modified asphalt mix is reported to be more susceptible to being affected by adverse weather or equipment problems. In addition, experience has shown that the rubber mixes tend to be "sticky", adhering to the equipment, making release from the delivery truck's bed more difficult and requiring extra care with water and additives in rolling to prevent adherence to the rollers. The higher the rubber content, the greater the difficulty. This is also true for compaction. The "stickiness" makes it difficult to work out voids, which can cause early failure.

The experience of the State of New York and that of others indicates clearly that the use of rubber in asphalt mixes increases the first cost because of the higher materials cost and increased plant processing and placement costs, particularly for higher rubber content mixes and under certain conditions. The extent to which the first cost might be reduced by more general use of rubber-modified asphalt mixes, much higher volumes of production and increased experience with the material is unclear at this point, but it would appear reasonable to expect that there would be an economy of scale, but of uncertain amount, clearly not achieved in the two pilot projects.

Likewise, from the experience to date with rubber-modified asphalt, it is not clear whether, and to what extent, a longer service life from rubber-modified asphalt can be expected to offset initially higher first costs. It will not be clear what the relative life cycle costs can be expected to be until the experience with the

pilot projects in New York State and elsewhere have provided a basis for estimating the service lives of rubber-modified asphalt in comparison with conventional asphalt. Until the experience with the pilot projects is available it also is not possible to project whether a lesser thickness of rubber-modified asphalt might provide an equal or better service life than conventional asphalt overlays.

A comparison of the application methods of conventional paving materials to rubber-modified asphalt and the ability to adapt equipment and processes, if necessary, to incorporate rubber in asphalt mix to the commissioner's specifications.

In general the preparation and application of rubber-modified asphalt are similar but more complex than for conventional mixes, not only because of the added complexity of having to add a controlled amount of granulated rubber into the mixing drum but also because of other adjustments necessary to the asphalt content and the aggregate and filler gradations. For the pilot projects, the normal process for laboratory mix was modified on a judgment basis to accommodate the addition and presence of crumb rubber. No standards now exist for either the laboratory testing of rubber-modified asphalt products or for evaluating the results in terms of achieving the optimum pavement performance. Therefore, the design of the mixes used in the two pilot projects was based, to a large degree, on engineering judgment and knowledge of the experience of others, as opposed to following established standards, which exist for conventional asphalt mixes.

Difficulties were encountered in obtaining a rubber-modified asphalt with an acceptable gradation (required distribution of the aggregate and other particle sizes in the mix). This is because the gradation of ground scrap tire rubber particles, as currently produced by the tire reclaiming industry, is not well suited for use in the conventional asphalt mixes used in New York State. However, were rubber-modified asphalts to be in widespread use, crumb rubber producers could be expected to produce virtually any desired size gradation.

The addition of rubber to the mix at the asphalt plant for the two pilot projects required additional laborers and a conveyor belt to handle the bagged rubber. Two laborers were required to feed the belt and two to place the bagged rubber in the aggregate hopper at the time of mixing. If the use of rubber-modified asphalt were to become more common, plant operators would probably choose to make modifications to the asphalt plants to automate this process, thereby eliminating the need for these additional laborers and the conveyor belt, and also eliminating the possibility of human error in achieving the desired mix characteristics. However, this may require the installation of a separate weighing system because the weight of the crumb rubber to be added to each batch of rubber-modified asphalt is below the accuracy or sensitivity tolerance of the current asphalt plant scales, which are designed and sized to weigh the heavy materials that go into and make up virtually the entire composition of an asphalt mix, rather than having the

capability of weighing a lighter density material possibly making up only 1 to 3 percent of the mix weight.

The hauling, spreading, and handling characteristics of rubber-modified asphalt are similar to those of conventional mixes, with some important differences. Temperatures above the level used for conventional mixes are required for rubber-modified asphalt during the mixing process at the asphalt concrete plant to assure appropriate mixing and to prevent the mix from stiffening during hauling as well as for the ease of spreading and rolling once delivered.

Concern has been expressed by plant operators for increased air pollution as a result of adding rubber to the mix and also the higher temperature required during mixing. There is an increased tendency for smoke to be emitted and the creation of a burning rubber smell. The potential health effects at the plant site should be evaluated if use of rubber-modified asphalt is to become widespread, given the high carbon black and petroleum derivative content of the rubber in tires.[4] The industry has also questioned whether the rubber content in the asphalt mix may create a health hazard if the pavement subsequently has to be ground down or milled, or if it is desired to recycle the material.

The material, particularly that with 3 percent rubber, tends to be "sticky", adhering to the equipment and to the dump truck bed. This was noted particularly with the proprietary product Plus-Ride. Equipment cleanup after using rubber-modified asphalt is more extensive and time-consuming.

The higher temperature mix delivered to the construction site proved to be too hot to compact. Therefore the compaction process at both of the pilot projects had to be delayed until mix temperatures fell below 280 degrees F. At the higher temperatures, the normal asphalt rolling procedures resulted in "shoving" of the rubber-modified asphalt during rolling.

The normal maximum theoretical density requirement of New York State standard asphalt concrete mixes of 95% to 98% was waived for the rubber-modified asphalt sections because this specification was thought to be unobtainable based on our laboratory results and previously reported field experience by others. The purpose of compaction, and the setting of maximum density standards as a way to determine the sufficiency of the compaction (rolling) process, is to assure that the mix is free of voids to the maximum extent possible. This provides a "solid" product capable of withstanding stresses without premature failure or depressions or rutting under load. If rubber-modified asphalt is to be given more widespread use, it will be necessary to develop new ways (instruments, tests or methods) to evaluate the sufficiency of compaction and the achievement of an extremely low percentage of voids in the compacted mix so as to avoid early failures.

The experience with the proprietary rubber-modified asphalt product, Plus-Ride, showed that it, in particular, tended to adhere to the equipment, was sticky and difficult to move and did not appear to

compact well under the weight of the rollers. It was found particularly necessary to have the rollers clean and slippery whenever rolling. The rollers had to be kept wet with water to which a soap or detergent was added. This probably would have to be made standard practice when rolling any rubber-modified asphalt mix.

Performance of rubber-modified asphalt as compared to conventional materials with regard to longevity of pavement, traction, road glare, icing, and such other characteristics as may be deemed appropriate by the commissioner.

Most field experience with rubber-modified asphalt does not show evidence of improved performance[2],[3],[4],[5] that has been inferred from the evaluation of laboratory tests of the material's properties. The findings in other States, i.e., Alaska, California, Connecticut, and Washington reported by the Federal Highway Administration[3] indicate that since their construction rubber-modified asphalt mixes have not provided substantial performance benefits over conventional hot-mix asphalt concrete pavements. The FHWA is expected to report periodically on the results as these pavements continue to age. In a recently completed study evaluating the proprietary "Plus-Ride" rubber modified mix, Minnesota reported[7] slightly lower tire friction numbers, slightly rougher Mays ride meter measurements, no significant altering of the tendency of asphalt pavements to crack, nor any significant deicing benefits. Minnesota concluded that rubber-modified material is capable of performing as well as conventional material if properly constructed; however, they recommend against its use because it demonstrates no significant benefits in pavement performance, durability, or safety, but it costs significantly more.

It is too soon to comment substantively on long-term pavement performance of rubber-modified asphalt in New York State; however, based upon our evaluation of the test sections at the two pilot project locations, which have been in service for approximately a year, we have no indication that the rubber-modified asphalt will perform any differently in New York State from that reported by other states.

Available literature sustains the premise that rubber-modified asphalt, if satisfactorily mixed, placed and compacted, will, on average, perform at least as well as the conventional asphalt mixes, but thus far there is no basis for assuming that rubber-modified mixes will exceed the performance of conventional asphalt mixes. While laboratory tests of the material's characteristics imply there should be a degree of improvement, no significant improvements have been demonstrated in actual field performance.

Although there have been many anecdotal reports of improved performance from rubber-modified asphalt in terms of service life, improved stopping distance and ability to reduce the bonding of ice to pavement, such performance has not been shown in controlled field tests of the material. Likewise, laboratory material test of rubber-modified asphalts, and measurement of their characteristics, that implied that an extended life and other performance

improvements could be expected did not attempt to reflect the climatic and traffic conditions that the material would have to withstand in actual use. Laboratory tests typically were at a single laboratory temperature rather than in the full range of at least -25° F to 110° F that can be expected in states such as New York.

Although extrapolations of the laboratory materials test results have been made to infer projected service lives and life cycle costs, there appears to be little if any reason to assume these projections have any validity since they have not taken into account the real-life conditions the materials will be exposed to.

> The findings of the Commissioner as the optimum and appropriate percentage of scrap rubber in rubber-modified asphalt paving mixtures for construction or improvement of state highways in consideration of projected performance, safety, and costs.

A longer evaluation period of the two pilot test projects will be needed before an optimum rubber percentage can be determined. Not enough time has elapsed to show any difference in the behavior and life of the pavements with the different percentages of crumb rubber used in the pilot projects. Monitoring of these sites will be required for at least five years before it can be expected that there will be any indication of differences amongst the rubber-modified asphalt mixes and in comparison to conventional asphalt mixes.

Since the initial cost for rubber-modified asphalt in highway pavements is high, from 50 to over 100 percent higher in the two pilot test projects and, once in widespread use, estimated to be from 20 to 50 percent or more above conventional asphalt mixes, its use can be justified only if it will have a longer service life, improved safety characteristics or other such attribute to warrant the higher cost, or from a public policy standpoint it is determined that use of scrap tires in highway asphalts is the preferred method of disposal. The life-cycle costs for the rubber-modified asphalt pavements can only be determined once the test sections have been in place for possibly as long as 10 or more years, in order to obtain a realistic assessment of performance and safety.

While there is no optimum value of a crumb rubber percentage for use in an asphalt mix that can be selected at this time, pending the life-cycle experience with the various mixes, a one or two percent crumb rubber content in an asphalt mix appears to be a reasonable amount to assume for comparison purposes.

> The quantity of rubber that would be used annually if the percentage of rubber content recommended by the Commissioner were to be utilized in rubber-modified asphalt paving mixtures for all contracts for the construction or improvement of state highways or sections thereof.

The New York State Legislative Commission on Solid Waste Management estimates that 12 million tires a year are discarded in New York State alone, and that more than 15 million tires have been either stockpiled or are in landfills throughout the State. If cost were of no concern, it is estimated that it would be possible for nine million scrap tires in the form of crumb rubber to be used in state highway paving materials annually. This number of tires would appear to be readily available under current conditions.

However, other uses are being made of tires.[8] One is to extract from them the petroleum products they contain. With increasing energy costs and projected shortages of petroleum, this may prove to be a financially feasible and environmentally desirable proposition that might be embraced as a highly appropriate undertaking from a national policy standpoint. Engineering News Record[9] reports that, a "waste tire to energy" plant currently being planned for Lackawanna, New York is projected to consume almost the entire scrap tire waste stream in New York State. This plant is expected to be operational in 1992. A plant of similar size being constructed in Sterling, Connecticut is scheduled to be operational in 1991. These plants will utilize whole tires in a closed system to produce about 30 Megawatts of power for sale to local utilities. To achieve this level of power production requires about 10 million scrap tires per year for each plant. It will require an assured annual supply of scrap tires that is nearly equal to the entire New York State annual scrap tire waste stream. The Connecticut plant is also planning on using scrap tires from New York, as well as other adjoining states. Once these plants are on line, there may no longer be a tire disposal problem in the Northeast. However, the plants will create a market for tires with the potential for the cost of scrap tires to rise above that used as a basis for estimating the cost of rubber-modified asphalt. This will have to be watched as the use of rubber in asphalt paving continues to be considered.

Since the use of scrap rubber in highway paving will add considerably to highway costs without, at this time, any assurance of such benefits as improved performance or reduced maintenance, environmental and market conditions will have to be weighed in the light of the ongoing experience in New York and elsewhere in the use of rubber-modified asphalt. Until a long-term evaluation of the costs and benefits associated with the use of scrap rubber can be completed, the Department of Transportation believes that any recommendation at this time to make widespread use of scrap rubber tires in asphalt would be inappropriate and premature. Such an evaluation should include consideration of competitive methods of disposal for profitable undertakings being pursued by the private sector, as well as the unknown and yet to be explored potential health consequences of using rubber in asphalt as against other disposal methods.

Existing or potential impediments to the maximum utilization of rubber-modified asphalt in contracts for the construction or improvement of state highways.

The major impediment to maximizing the use of rubber-modified asphalt in contracts for the construction or improvement of state highways is one of cost. The cost of using rubber-modified asphalt for the two pilot projects was from 50 percent greater in the one project to 129 percent greater in the second project compared to using a conventional asphalt mix. This increase in cost undoubtedly could be reduced with more widespread use, higher volumes of production, the addition of automated handling of the rubber at the asphalt plant, greater experience and training of the workers both at the plant and the construction site, development of appropriate new techniques to evaluate the adequacy of compaction of the rubber-modified asphalt, satisfactory resolution of the questions of health and environmental effects of use of the rubber material at high temperature, as well as questions of recyclability of the material, and an ability to meet the increased energy consumption associated with use of the material. Resolution of each of these factors would in itself require an investment or expenditure that adds to the impediment of higher cost of the delivered material.

The Department's 1986 report showed that the estimated extra cost associated with using rubber-modified asphalt for highway pavements would amount to approximately $11 per tire used. What was concluded then, and is the conclusion of this report, that this added cost would not assure that an improved performance, life cycle cost, or safety would result. At the same time, it appears that cost effective and productive other uses of scrap rubber tires have been developed, with plans to apply them under construction or being actively considered. These other uses have promise of fully using the projected scrap tire waste stream, including the existing stockpiles of waste tires.

Recommendations of the Commissioner as to future actions that could be taken by the Department of Transportation, the Governor and the Legislature to facilitate the use of scrap rubber for highway construction or improvement.

Since the primary impediment in increasing use of the rubber-modified asphalt is the higher cost without an indication that there would be counterbalancing benefits, actions to eliminate the cost differential would appear to be the most promising. However, as our 1986 report showed, the cost differential is the equivalent of approximately $11 for each tire used. Were tire purchasers required to pay that amount into a tire disposal fund to be used to equalize the cost of rubber-modified asphalt and conventional asphalt mixes, it would eliminate this major impediment, assuming the other lesser impediments, expenditures, investments and concerns are also addressed and resolved.

However, such a large assessment on tire purchasers would represent a significant increase in the cost of tires. For a small automobile tire the increase in price would be about 40 percent. Such a large burden on purchasers should result in serious consideration of other potential uses of scrap tires that may have the prospect of being either self supporting or requiring a lesser subsidy than use in highway pavements.

Given the urgent need for the State to provide for a major increase in funding for highways and bridges simply to keep conditions at a status quo level, it does not appear feasible to expect that an additional $100 million would be provided annually to the highway program to finance the extra costs that would result from using rubber-modified asphalt.

Since other promising, productive and cost effective uses of scrap rubber tires will soon be coming on line, either of the above two possible actions would not appear to be prudent or needed. Given the above, it appears that it would be neither necessary or appropriate at this time to engage in any more widespread pilot test projects using rubber-modified asphalt, or to address the environmental and health concerns, the investment in plant equipment, training of workers, etc., relating to such use of scrap rubber tires.

> An analysis of the potential for the use of rubber-modified asphalt by local governments, regional and statewide authorities governing the construction or improvement of highways or bridges, including, but not limited to: "(a) The projected annual demand for scrap rubber by local governments, regional and statewide authorities, based upon the percentage mix in asphalt for rubber derived from motor vehicle tires recommended by the Commissioner; and (b) known or anticipated impediments to the maximum utilization of rubber-modified asphalt by local governments, regional and statewide authorities."

The total amount of asphalt used annually for highway purposes in New York State has averaged about 13 million tons. It has been estimated by the National Asphalt Pavement Association that about 30 percent of a Northeastern and Mid-Atlantic state's total asphalt usage could be expected to be for non-state roads. This would amount to almost 3.8 million tons annually. The Association's estimates are that about 68 percent of the asphalt used in these states is for the highway pavement surfacing and binder courses, the portions of a highway's structure that includes the top or wearing course of the highway that could potentially benefit from the use of rubber-modified asphalt. This would imply that about 2.5 million tires could reasonably be expected to be used by local governments and authorities annually were they to use rubber-modified asphalt instead of conventional asphalt pavement material for the wearing course of highway resurfacing projects.

The major impediments for local governments and authorities to use rubber-modified asphalt are the same as noted above for the state. In addition, many of the local governments would tend to be using small amounts of asphalt paving material at any one time and for smaller projects. The need for training of the local government road crews in the use of the rubber-modified asphalt would also tend to impede its use. By the same token, the asphalt plants they may be using may be smaller and less likely to find it practical to train their personnel and to convert to using a rubber additive in mixing asphalt.

Actions that may be necessary to ensure the availability of an adequate supply of scrap rubber to meet projected demand in the construction or improvement of public highways.

To ensure that scrap tires are available might require legislation to outlaw their disposal in land fills or other inaccessible sites. This, presumably, would also require that disposal sites for tires be developed that are reasonably available throughout the state, and that all tires be required to be collected and delivered to these sites.

As noted earlier in this report, the extent that competitive uses develop for scrap tires will determine whether it will be possible to ensure that scrap tires will be available for rubber-modified asphalt. The market forces will determine tire availability and the price that might have to be paid for them. Since the competitive users, such as power plants, would not require tires to go through an intermediate processing, such as is required in order to retrieve granulated or crumb rubber, the price of crumb rubber might be forced to rise in order to attract a scrap tire supply on an assured delivery basis.

It is recommended that the appropriate state agencies and legislative committees follow the developing markets for scrap tires and to consider whether legislative action might be appropriate to assure that scrap tires are removed form the solid waste disposal stream so they can be available for productive uses.

An estimation of the additional expense, if any, to the state or localities in the utilization of rubber-modified technologies.

As has been noted above, rubber-modified asphalt is more costly than conventional asphalt mixes. Current costs are from 50 percent to more than 100 percent higher. Although it is inherently more costly to produce, it has been assumed that prices would decline with more widespread use, higher volumes of production and accumulated experience and training by asphalt plant operators and contractors in its use.

This has resulted in estimates that in the long term, rubber-modified asphalt might be from 25 percent to 50 percent more costly than conventional asphalt mixes. This did not take into account market forces resulting from developing competitive uses. Nonetheless, using this assumed long term cost relationship, implies that the added cost to the state, and local governments and authorities in the state, would be as much as $100 million annually were rubber-modified asphalt to be used instead of conventional asphalt mixes for the top or wearing course of highway pavements. In the initial years of a change-over the costs would tend to be even higher. Unless the affected agencies were to provide the extra funding to cover these added costs, their highway and bridge infrastructure would suffer from underfunding and deferral of needed work, with ultimately higher cost consequences because of deterioration and failures that could otherwise have been avoided.

REFERENCES
Noted in the Text

1. Governor's Memorandum of Disapproval of A-7020A, August 2, 1985.

2. Use of Scrap Automobile Tire Rubber in Highway Construction, Report to the Governor, May 1986, New York State Department of Transportation.

3. Bernard, Douglas, Testimony on Scrap Tire Management and Recycling Opportunities, before the House Committee on Small Business Subcommittee on Environment and Labor and Subcommittee on Regulation, Business Opportunities and Energy, April 18, 1990.

4. Kearney, Edward J., Industry Concerns Relative to the Use of Waste Tire Rubber in Asphalt Pavements, in Waste Tires in New York State, Alternatives to Disposal, November, 1987.

5. ARE, Inc., Evaluation of the Use of Rubber-Modified Asphalt Mixtures for Asphalt Pavements in New York State, December 1989.

6. Chamberlin, W. P. and Gupta, P. K., Inspection of Experimental Rubber-Modified Asphalt Pavements in Connecticut, New York State Department of Transportation, February 1987.

7. Allen, H. S. and Turgeon, Evaluation of Plus-Ride (TM) (A Rubber-Modified Plant Mixed Bituminous Surface Mixture), Minnesota Department of Transportation, January 1990.

8. Schnormeier, Russell H., Tires Recycled into Pavements, in Waste Tires in New York State, Alternatives to Disposal, November 1987.

9. "Tire Burning Plants Rolling Along", Engineering News Record, May 10, 1990.

10. Doty, Robert N., Flexible Pavement Rehabilitation Using Asphalt-Rubber Combinations - A Progress Report, California Department of Transportation, January 1990.

11. Doty, Robert N., Flexible Pavement Rehabilitation Using Asphalt-Rubber Combinations - A Progress Report, California Department of Transportation, January 1988.

12. Stephens, Jack E., Nine Year Condition Survey of Connecticut DOT Experimental Rubber/Asphalt Applications, in Waste Tires in New York State, Alternatives to Disposal, November 1987.

13. McQuillen, J. L.; Takallou, H. B.; Hicks, R. G. and Esch, D. C., Economic Analysis of Rubber Modified Asphalt Mixes, undated.

APPENDIX

HIGHWAYS—USE OF SCRAP RUBBER IN CONSTRUCTION AND IMPROVEMENT

CHAPTER 599

Approved and effective Aug. 3, 1987

AN ACT to amend the highway law, in relation to the utilization of scrap rubber in the construction and improvement of highways

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

§ 1. Legislative intent. The legislature finds that the environmentally acceptable disposal of used motor vehicle tires within the state cannot be accomplished by landfilling or incineration techniques commonly employed in the disposal of municipal solid waste. The lack of disposal options and of markets for scrap tires has resulted in the stockpiling of large quantities of tires in locations across the state. Such stockpiles pose a potential environmental and health hazard.

The legislature further finds that the reuse of scrap rubber in paving materials in the construction or improvement of highways is a promising commercial process, which has been increasingly employed in highway construction in other states.

The legislature duly notes that the concept of the use of scrap rubber derived from used motor vehicle tires in the construction of highways has been endorsed by the federal government. The 1982 Surface Transportation Assistance Act[1] contains incentives to state governments to encourage the use of recycling and use of various additives in asphalt construction, of which rubber is one. The New York state department of transportation has used rubber in asphalt construction experimentally, allows its use in curbing mix, and for other uses.

In recognition that recent research shows that rubber-modified asphalt paving material may add to the life and safety of public highways, and in recognition that New York state should consider utilizing this material in some beneficial way that will help to eliminate a potential hazard to public health and to the environment, the legislature hereby enacts the following provisions.

[1] 23 U.S.C.A. § 101 et seq.

§ 2. The highway law is amended by adding a new section twenty-three to read as follows:

§ 23. Rubber-modified asphalt pilot project

1. The commissioner shall undertake in nineteen hundred eighty-eight, a pilot project for the utilization of rubber-modified asphalt in the construction or improvement of state highways. Such rubber-modified asphalt pilot project shall utilize rubber derived from motor vehicle tires discarded in the state, including but not limited to use in granulated form as a percentage of asphalt mix and use as a joint material, and may be required in a contract or contracts for capital construction or improvement of highways in fiscal year nineteen hundred eighty-nine.

2. On or before April first, nineteen hundred eighty-nine, the commissioner of transportation shall submit a report to the governor, to the speaker of the assembly and to the president pro tem of the senate. In making such report, the commissioner may make use of and report on existing studies, analyses and pilot projects conducted within or outside the state by other states or the federal government, along with any other sources of information he deems appropriate. Such report shall include a summary and analysis of the procedures and results of the pilot project, including the following:

(a) a comparison of costs of conventional asphalt mixes to the costs of the use of rubber-modified asphalt;

(b) a comparison of the application methods of conventional paving materials to rubber-modified asphalt and the ability to adapt equipment and processes, if necessary, to incorporate rubber in asphalt mix to the commissioner's specifications;

(c) performance of rubber-modified asphalt as compared to conventional materials with regard to longevity of pavement, traction, road glare, icing, and such other characteristics as may be deemed appropriate by the commissioner;

(d) the findings of the commissioner as to the optimum and appropriate percentage of scrap rubber in rubber-modified asphalt paving mixtures for construction or improvement of state highways in consideration of projected performance, safety and costs;

(e) the quantity of rubber that would be used annually if the percentage of rubber content recommended by the commissioner were to be utilized in rubber-modified asphalt paving mixtures for all contracts for the construction or improvement of state highways or sections thereof;

(f) existing or potential impediments to the maximum utilization of rubber-modified asphalt in contracts for the construction or improvement of state highways;

(g) recommendations of the commissioner as to future actions that could be taken by the department of transportation, the governor and the legislature to facilitate the use of scrap rubber for highway construction or improvement;

(h) an analysis of the potential for the use of rubber-modified asphalt by local governments, regional and statewide authorities governing the construction or improvement of highways or bridges, including, but not limited to:

(i) the projected annual demand for scrap rubber by local governments, regional and statewide authorities, based upon the percentage mix in asphalt for rubber derived from motor vehicle tires recommended by the commissioner; and

(ii) known or anticipated impediments to the maximum utilization of rubber-modified asphalt by local governments, regional and statewide authorities.

3. The commissioner shall further examine, and make recommendations regarding the following:

(a) actions that may be necessary to ensure the availability of an adequate supply of scrap rubber to meet projected demand in the construction or improvement of public highways; and

(b) an estimation of the additional expense, if any, to the state or localities in the utilization of rubber-modified asphalt technologies.

4. In the preparation of this report the commissioner shall consult with the county and other state governments, the New York state thruway authority, the port authority of New York and New Jersey and such public or private agencies as the commissioner deems appropriate.

§ 3. Section thirty-eight of such law is amended by adding a new subdivision two-a to read as follows:

2-a. Contracts; rubber-modified asphalt materials. In regard to contracts for construction or improvement of highways incorporating the use of asphalt construction materials after May first, nineteen hundred eighty-nine, the commissioner may require that the paving materials incorporate a percentage of scrap rubber derived from motor vehicle tires discarded in the state. Such percentage of rubber additives may be established by the commissioner subsequent to the completion of a rubber-modified asphalt pilot project to be conducted pursuant to section twenty-three of this chapter.

§ 4. This act shall take effect immediately.

STATE OPERATIONS

DEPARTMENT OF TRANSPORTATION--Cont.

the percentage of lane miles with surface scores less than six (6) to a percentage equal to or less than the statewide percentage of roads with surface scores less than six (6).

On or before December 31, 1987, the commissioner shall report to the director of the budget and the chairmen of the senate finance committee and the assembly ways and means committee on the result of such program and provide a recommendation on the feasibility of continuing such program 2,000,000

For expenses of emergency response teams on the Long Island Expressway 339,000

For expenses of examining and evaluating the technology and cost of using rubber-modified asphalt systems in the construction and improvement of highways, such evaluation to consider the environmental and economic impact of using these materials and to include one or more experimental installations at specific sites of high winter accident frequency; and for expenses of examining the feasibility of the use of coal combustion by-products generated in the state, for the purpose of, but not solely limited to, large volume applications of such by-products as embankments and/or as fill 300,000

Amount available for maintenance undistributed 85,434,000

Special Revenue Fund - Other
Miscellaneous Special Revenue Fund - 339
Divisible Load Permit Account

For expenses of highway pavement maintenance ... 9,815,000

Notwithstanding any other provision of law, the comptroller is hereby authorized and directed to receive for deposit to the credit of the miscellaneous special revenue fund any revenues obtained pursuant to section 385 of the vehicle and traffic law, including fees, fines, penalties and forfeitures.

The comptroller is further authorized and directed to loan money by transfer to this

HIGHWAY CONSTRUCTION—USE OF COAL COMBUSTION BY-PRODUCTS

CHAPTER 698

Approved and effective Aug. 5, 1987

AN ACT to amend the highway law, in relation to the utilization of coal combustion by-products in the construction and improvements of highways

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

§ 1. Legislative intent. The legislature finds that the reuse of coal combustion by-products for fill and embankments in the construction or improvement of highways is a promising alternative, which has been increasingly employed in highway construction in other states, and should be evaluated in New York state.

§ 1. Legislative intent

The legislature duly notes that the concept of using coal combustion by-products in the construction of highways is consistent with the nineteen hundred eighty-four amendments of the federal Resource Conservation and Recovery Act,[1] which encourages efforts to utilize materials from the waste stream through government procurement practices.

In recognition that New York state should consider utilizing coal combustion by-products in some beneficial way that will help eliminate a potential disposal problem, the legislature hereby enacts the following provisions.

[1] 42 U.S.C.A. § 6901 et seq.

§ 2. The highway law is amended by adding a new section twenty-three to read as follows:

§ 23. Coal combustion by-product demonstration project

1. The commissioner shall undertake in nineteen hundred eighty-eight, after consultation with and in cooperation with the commissioner of environmental conservation, a

demonstration project utilizing coal combustion by-products in the construction or improvement of state highways. Such project shall demonstrate the feasibility of the use of coal combustion by-products generated in the state, for the purpose of, but not solely limited to, large volume applications of such by-products as embankments and/or as fill.

2. On or before April first, nineteen hundred eighty-nine, the commissioner and the commissioner of environmental conservation shall submit a report to the governor, to the speaker of the assembly and to the president pro tem of the senate. In making such report, the commissioner shall make use of and report on existing studies, analyses and pilot projects conducted by the state of New York or the other states or the federal government, and such other sources of information they deem appropriate. Such report shall summarize and analyze the demonstration project and other data and information compiled by the commissioners. Such summary and analysis shall include:

(a) a comparison of costs of conventional embankment and fill materials to the costs of the use of coal combustion by-products for such purposes;

(b) a comparison of the methods of application of conventional embankment and fill materials to the application of coal combustion by-products for the same purposes and the ability to adapt equipment and processes, if necessary, to incorporate coal combustion by-products into the commissioner's specification for embankments and fill;

(c) a comparison of the performance of coal combustion by-products to conventional materials with respect to stability, erosion, environmental compatibility and such other similar characteristics as may be deemed appropriate by the commissioners;

(d) a comparison of the environmental benefits and detriments of the use of coal combustion by-products with those of alternative products or materials;

(e) the findings of the commissioner as to the optimum and appropriate percentage of coal combustion by-products for construction or improvement of state highways in consideration of projected performance, and costs;

(f) a finding of the quantity of coal combustion by-products that would be used annually if the percentage of coal combustion by-products recommended by the commissioners were to be utilized in embankments and fills for contracts for the construction or improvement of state highways or sections thereof;

(g) a description of existing or potential impediments to the maximum utilization of coal combustion by-products in contracts for the construction or improvement of state highways;

(h) recommendations of the commissioner as to future actions that could be taken by the department, the governor and the legislature to facilitate the use of coal combustion by-products for highway construction or improvement;

(i) an analysis of the potential for the use of coal combustion by-products by local governments, regional and statewide authorities governing the construction or improvement of highways or bridges, including, but not limited to:

(i) the projected annual demand for coal combustion by-products by local governments, regional and statewide authorities, based upon the percentage recommended by the commissioner for use in fills and embankments; and

(ii) known or anticipated impediments to the maximum utilization of coal combustion by-products by local governments, regional and statewide authorities; and

(j) an estimation of the additional expense, if any, to the state or localities in the utilization of coal combustion by-products technologies.

3. The commissioner shall further examine, and make recommendations regarding the following:

(a) actions that may be necessary to ensure the availability of an adequate supply of coal combustion by-products to meet projected demand in the construction or improvement of public highways;

(b) methods of encouraging the use of coal combustion by-products in concrete and asphalt applications.

4. In the preparation of this report, the commissioner and the commissioner of environmental conservation shall consult with the county and other state governments, the New York state thruway authority, the port authority of New York and New Jersey and such public or private agencies as the commissioner deems appropriate.

§ 3. This act shall take effect immediately.